

UNITED STATES PATENT AND TRADEMARK OFFICE  
DOCUMENT CLASSIFICATION BARCODE SHEET

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CATEGORY:

CLEARED

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ADDRESS  
CONTACT IF FOUND:

TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371

A-70162/JAS

U.S. APPLICATION NO. (If known, sect 37 C.F.R. 1.5)

09/720755

INTERNATIONAL APPLICATION NO

PCT/GB99/02029

INTERNATIONAL FILING DATE

June 28, 1999

PRIORITY DATE CLAIMED

June 27, 1998

TITLE OF INVENTION

COALESCER

APPLICANT(S) FOR DO/EO/US

TURNBULL, Robert William

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ has been transmitted by the International Bureau. [see enclosed Form PCT/IB/308]
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (Unsigned)
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.  
☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:

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17. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492(A)(1)-(5)):**

Search Report has been prepared by the EPO or JPO ..... \$860.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) ..... \$690.00

No international preliminary examination fee paid to USPTO (37 CFR 1.482) but  
international search fee paid to USPTO (37 CFR 1.445(a)(2)) ..... \$710.00Neither international preliminary examination fee (37 CFR 1.482) nor international  
search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$1,000.00International preliminary examination fee paid to USPTO (37 CFR 1.482) and all  
claims satisfied provisions of PCT Article 33(2)-(4) ..... \$100.00**ENTER APPROPRIATE BASIC FEE AMOUNT =**

\$ 860.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30  
months from the earliest claimed priority date (37 CFR 1.492(e)).

\$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total Claims	12	-20 =	0
Independent Claims	3	-3 =	0
Multiple dependent claims (if applicable)			+ \$270.00

\$

**TOTAL OF ABOVE CALCULATIONS =**

\$ 860.00

Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement  
must also be filed (Note 37 CFR 1.9, 1.27, 1.28).

\$

**SUBTOTAL =**

\$ 860.00

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30  
months from the earliest claimed priority date (37 CFR 1.492(f)).

+

\$

**TOTAL NATIONAL FEE =**

\$ 860.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied  
by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property

+

\$

**TOTAL FEES ENCLOSED =**

\$ 860.00

Amount to be:  
refunded \$

charged \$

a. ☒ A check in the amount of \$860.00 to cover the above fees is enclosed.b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_ to cover the above fees.  
A duplicate copy of this sheet is enclosed.c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment  
to Deposit Account No. 06-1300/A-70162/JAS. A duplicate copy of this sheet is enclosed.**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must  
be filed and granted to restore the application to pending status.**

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

R. MICHAEL ANANIAN  
NAMEREG. NO. 35,050  
REGISTRATION NUMBER

**PATENT**

Attorney Docket No.: A-70162/JAS

In re application of: )  
TURNBULL )  
 )  
**NATIONAL PHASE ENTRY OF:** )  
PCT/GB99/02029 )  
 )  
Serial No.: Not Assigned )  
 )  
Filed: Herewith )  
 )  
For: COALESCER )  
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**BOX PCT**

Assistant Commissioner for Patents  
Washington, D.C. 20231

**PRELIMINARY AMENDMENT**

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application  
as follows:

**IN THE CLAIMS:**

Please amend the claims as follows:

(Unchanged) 1. An apparatus for coalescing droplets of one  
phase from a fluid comprising two or more phases, said apparatus  
comprising a chamber, a coalescing medium comprising a plurality of  
substantially elongate members each having a surface area, a retaining  
member to which the coalescing medium is secured, an inlet to said

chamber, and an outlet from said chamber, said inlet and outlet being positioned such that fluid flowing from said inlet to said outlet flows in a flow direction in contact with said surface area of said coalescing medium, the elongate members extending substantially in the flow direction, characterised in that said chamber is formed from a substantially straight pipe having a first end and a second end and a branch intermediate said first and second ends, said outlet being arranged at the first end and an access cover being arranged at the second end, said inlet being arranged at the free end of said branch, wherein said access cover is adapted to allow removal and replacement of the retaining member and coalescing medium.

(Unchanged) 2. An apparatus in accordance with Claim 1, wherein said retaining member is adapted to be removably engaged within said chamber.

(Amended) 3. An apparatus in accordance with Claim 1 [or Claim 2], wherein the interior of said chamber is provided with a shoulder adapted to engage with said retaining chamber.

(Unchanged) 4. An apparatus in accordance with Claim 3, wherein said access cover is adapted to hold said retaining member against said shoulder when the access cover is attached to the pipe.

(Amended) 5. An apparatus in accordance with [any of Claims 1 to 4] Claim 1, wherein said retaining member is provided with one or more apertures for securing said coalescing medium to said retaining member.

(Amended) 6. An apparatus in accordance with [any preceding claim] Claim 1, wherein said plurality of elongate members are substantially mutually aligned fibres.

(Unchanged) 7. An apparatus in accordance with Claim 6, wherein said coalescing medium comprises ribbon-like fibres.

(Unchanged) 8. An apparatus in accordance with Claim 6, wherein said fibres are selected from the group of materials comprising polypropylene, metal wire, animal hair, polyethylene, polyester, and glass wool.

(Amended) 9. An apparatus in accordance with [any of Claims 1 to 6] Claim 1, wherein said coalescing medium comprises one or more polypropylene ropes.

(Unchanged) 10. A method for coalescing droplets of one phase from a fluid comprising two or more phases using the apparatus of any preceding Claim, in which the fluid is caused to flow in a flow direction through the chamber, each of the plurality of substantially elongate members being substantially aligned in the flow direction, such that the fluid flows in contact with said surface area of said coalescing medium and droplets of a first phase of said fluid coalesce on said surface area.

(Unchanged) 11. A method in accordance with Claim 10, wherein the fluid is a liquid.

(Unchanged) 12. A method in accordance with Claim 11, wherein the fluid is a mixture of water and oil, and wherein the first phase is oil.

Please add claim 13.

(New) 13. An apparatus for coalescing droplets of one phase from a fluid comprising two or more phases, said apparatus comprising a chamber, a coalescing medium comprising a plurality of substantially elongate members each having a surface area, a retaining member to which the coalescing medium is secured, an inlet to said chamber, and an outlet from said chamber, said inlet and outlet being positioned such that fluid flowing from said inlet to said outlet flows in a flow direction in contact with said surface area of said coalescing medium, the elongate members extending substantially in the flow direction, characterised in that said chamber is formed from a substantially straight pipe having a first end and a second end and a branch intermediate said first and second ends, said outlet being arranged at the first end and an access cover being arranged at the second end, said inlet being arranged at the free end of said branch, wherein said access cover is adapted to allow removal and replacement of the retaining member and coalescing medium;

said retaining member is adapted to be removably engaged within said chamber;

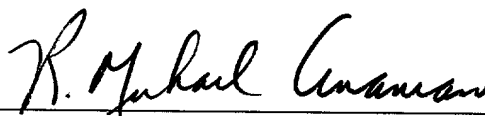
the interior of said chamber is provided with a shoulder adapted to engage with said retaining chamber.

## REMARKS

The Examiner is respectfully requested to enter the above amendments to the specification prior to examination. No new matter is added.

If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned at (650) 494-8700.

Respectfully submitted,



R. Michael Ananian, Reg. No. 35,050  
for: James A. Sheridan, Reg. No. 25,435

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PTO/PCT Rec'd 27 DEC 2000

COALESCER

1

2

3 This invention relates to an apparatus and method for  
4 encouraging droplet growth within a two phase liquid  
5 feed stream, particularly a liquid phase stream  
6 comprising oil and water or solvent and water.

7 However, the invention is applicable to any fluid feed  
8 stream in which there are at least two different  
9 phases, for example a continuous phase and a dispersed  
10 phase, a liquid phase and a non-liquid phase, or a  
11 mixture of gas phases such as in gas scrubbing  
12 applications.

13

14 It has been observed that for a significant number of  
15 processes which generate a two phase waste flow the  
16 efficiency of liquid treatment plant is no longer  
17 providing the desired level of phase removal. This, in  
18 many instances, is due to the feed containing  
19 relatively significant volumes of the minority phase in  
20 the form of small droplets (eg typically of the order  
21 of 10  $\mu\text{m}$  or less). These droplets provide a challenge  
22 for standard phase separation devices that are commonly  
23 used.

24

25 Chemical flocculants, downstream skimmed enhancement

1 vessels, centrifuges, media filters and membranes have  
2 all been considered as potential enhancement mechanisms  
3 to deal with the problems of small droplets.

4  
5 In many instances the cost or space required to utilise  
6 such technologies is limited. If small droplets can be  
7 coalesced or "grown" to a greater size, then the  
8 existing equipment should perform in a more efficient  
9 manner.

10  
11 US Patent No 3,810,832 discloses a coalescing apparatus  
12 in which elongated filaments of polypropylene are  
13 arranged across the flow of the mixture. The mixture  
14 has to pass across the filaments of polypropylene,  
15 which therefore impede the flow. US Patent No  
16 4,299,699 discloses a combined coalescing/filtration  
17 apparatus in which elongated strands of yarn form a  
18 cylindrical assembly. The oil-in-water suspension must  
19 pass from the outside to the inside of the cylindrical  
20 assembly and therefore has to pass perpendicular to the  
21 strands, which substantially impede the flow.

22  
23 It is an object of the present invention to provide an  
24 apparatus and method in which droplets in a two phase  
25 liquid feed stream can be coalesced to a greater size.

26  
27 According to a first aspect of the present invention  
28 there is provided an apparatus for coalescing droplets  
29 of one phase from a liquid comprising two or more  
30 phases, the apparatus comprising a chamber, a  
31 coalescing medium comprising a plurality of  
32 substantially elongate members each having a surface  
33 area, means for securing said coalescing medium within  
34 said chamber, an inlet to said chamber, and an outlet  
35 from said chamber, said inlet and outlet being  
36 positioned such that liquid flowing from said inlet to

1 said outlet flows in a flow direction in contact with  
2 said surface area of said coalescing medium, the  
3 elongate members extending substantially in the flow  
4 direction. The longitudinal members may not be  
5 perfectly straight, and may be crinkled, creased,  
6 twisted or irregularly deformed, but they extend in a  
7 direction which is substantially parallel to the flow  
8 direction, such that liquid flows along the  
9 longitudinal members in contact with the surface area  
10 of the coalescing medium.

11  
12 Preferably said coalescing medium has a high surface  
13 area per unit volume. Preferably said coalescing  
14 medium comprises a plurality of elongate members in the  
15 form of fibres. The fibres may be substantially  
16 mutually aligned. Preferably the fibres are of  
17 natural, man made or plastic material. The fibres may  
18 be polypropylene, metal wire, animal hair,  
19 polyethylene, polyester or glass wool. Preferably the  
20 coalescing medium comprises one or more polypropylene  
21 ropes. However, other forms of fibres are possible, as  
22 described below:

23  
24 Fibres may be prepared in a variety of cross-sectional  
25 shapes according to the fluid components and  
26 performance required.

27  
28 The fibres may be either regular or irregular in  
29 dimension and solid, hollow or open structured in  
30 nature.

31  
32 The fibres may be formed by spinning, weaving,  
33 extruding, moulding or cellular growth as in animal or  
34 plant products.

35  
36 The fibres may be surface modified by smoothing,

1 roughening, chemical coating, precipitation deposition  
2 or other commonly available techniques for specific  
3 applications.

4  
5 The fibres may be installed as separate fibres, or as  
6 groups or bunches in a single or plaited grouping to  
7 increase the tortuosity of the fluid flow path.

8  
9 The fibres may be treated mechanically, thermally,  
10 chemically or by a mixture of treatments to generate a  
11 wave or curl along the length of the fibre to increase  
12 the tortuosity of the fluid flow path. The fibres may  
13 be of greater or lesser density than the flowing  
14 fluids.

15  
16 The fibres may be chosen to react to a naturally  
17 occurring or artificially input component of the  
18 flowing fluids to promote a change in the property of  
19 the fibre. The property changes may include, but are  
20 not limited to, a dimensional change due to swelling or  
21 shrinking, a decrease or increase in rigidity or a  
22 change of interfacial tension between the fluids and  
23 the fibres.

24  
25 Preferably the chamber comprises a substantially  
26 straight pipe having a first end and a second end, said  
27 outlet being arranged at the first end and an access  
28 cover being arranged at the second end. Preferably the  
29 access cover is removable such as to allow access to  
30 said coalescing medium. In one embodiment the chamber  
31 further comprises a branch attached to an intermediate  
32 point of said pipe, said inlet being arranged at the  
33 free end of said branch. However, this form of inlet  
34 and outlet to the coalescing medium is not restrictive  
35 and either or both of the inlet and outlet may be  
36 inline, perpendicular or tangential to the direction of

1 flow within the vessel or conduit. The inlet and  
2 outlet configurations need not be the same, but can be  
3 adjusted to suit the design constrictions of the system  
4 in which it is placed.

5  
6 The application of the invention is not restricted to  
7 tubular systems, but may be placed in any suitable  
8 vessel or conduit which may, or may not, be open to the  
9 atmosphere. The chamber of the invention is not to be  
10 construed as being limited to a closed chamber, and may  
11 be an open channel, for example.

12  
13 The application of the invention is not limited to flow  
14 systems in which the vessel, pipe or conduit is  
15 completely filled with the continuous and dispersed  
16 phases.

17  
18 Preferably the apparatus further comprises a retaining  
19 member to which the coalescing medium is secured.  
20 Depending on the arrangement of the inlet and outlet,  
21 the coalescing medium may comprise fibres attached to a  
22 single point or to multiple points on the retaining  
23 member. The multiple points may be positioned in a  
24 plane transverse to the flow direction or in a plane  
25 parallel to the flow direction. Suitable attachment  
26 devices are apertures in the retaining member, threaded  
27 clamps, clamping rings and hooks or loops on the  
28 retaining member. The fibres may be bonded to the  
29 retaining member by adhesive or melt bonding.

30  
31 The attachment device for the fibres may include a  
32 perimeter sheath within which the fibres are located to  
33 promote ease of insertion or extraction from the  
34 flowing fluid stream or system.

35  
36 The attachment device may incorporate protective pads

1 or shields to prevent abrasion damage to the fibres due  
2 to detritus in the fluid stream.

3  
4 Preferably said retaining member is adapted to be  
5 removably engaged within said chamber. Preferably the  
6 interior of said chamber is provided with a lip adapted  
7 to engage with said retaining member. Preferably said  
8 access cover is adapted to hold said retaining member  
9 against said lip when the access cover is attached to  
10 the pipe. Preferably said retaining member is provided  
11 with one or more apertures for securing said coalescing  
12 medium to said retaining member.

13  
14 According to a second aspect of the present invention  
15 there is provided a method for coalescing droplets of  
16 one phase from a liquid comprising two or more phases,  
17 in which the liquid is caused to flow through a chamber  
18 in which is secured a coalescing medium having a  
19 surface area, such that the liquid flows in contact  
20 with said surface area of said coalescing medium and  
21 droplets of a phase of said liquid coalesce on said  
22 surface area. Preferably the method uses an apparatus  
23 according to the first aspect of the present invention.

24  
25 The present invention provides a simple process unit  
26 which can either be added to a process system when the  
27 system is constructed or be retrofitted into an  
28 existing process system to increase the efficiency  
29 and/or life of the process system. The coalescer  
30 utilises additional surface area within the pipe to  
31 assist the minority phase droplets to coalesce.

32  
33 In one embodiment the apparatus of the invention  
34 comprises a length of pipe fitted at each end with a  
35 pressure sealable fitting (eg a flange plate, which can  
36 be fixed to the pipe by welding, screw thread etc). At

1 one end of the pipe there is a "T" section fitted, with  
2 another pressure sealable fitting (eg a flange plate,  
3 again fixed by welding, screw thread etc). The  
4 pressure sealable fitting on the pipe closest to the  
5 "T" section is blanked off, and acts as a service and  
6 inspection access point for the coalescing retainer and  
7 media.

8  
9 The coalescing media extends within the pipe through  
10 the length of the unit and is retained by a retainer.  
11 The media retainer may be of disk type construction,  
12 and may have a number of drill holes therethrough to  
13 allow the media to be attached. The retainer is  
14 constructed from a stainless steel, or other suitable  
15 material that will not be prone to corrosion or wear in  
16 the environment under which this invention will have to  
17 operate. The media retainer is secured in position by  
18 appropriate means, for example by clamping between the  
19 shoulder of the pipe and the screw fitting of the  
20 blanketing plug, or by the retainer being restrained in  
21 the pipe by a welded lip/shoulder and being held in  
22 position by the flow of fluid around the media. It is  
23 envisaged that the coalescing media will be made from  
24 fibrous man-made or natural material such as  
25 polypropylene rope, metal wire, animal hair,  
26 polyethylene, polyester or glass wool.

27  
28 To ensure that the coalescing media is correct for the  
29 accumulation and thus the coalescing of the minority  
30 phase this invention will allow for the coalescing  
31 media to be fully interchangeable. The size and  
32 dimensional shape of the coalescer will be dependent on  
33 the flow characteristics of the fluid flowing through  
34 the apparatus, such as Reynolds Number, fluid type,  
35 dispersed phase size, desired level of dispersed phase  
36 coalescence, desired or allowable system pressure drop,

1 system temperature, flow volume, and weight and space  
2 restrictions. For example, if a high Reynolds Number  
3 is required, a smaller effective cross sectional area  
4 is required for the same flow. In the case of a  
5 chamber formed by a pipe, this could be achieved by  
6 either reducing the pipe diameter, or increasing the  
7 cross sectional area that is occupied by the coalescing  
8 media. Typically the pipe may be between 10mm and  
9 100mm in diameter, although larger pipes may be used.

10

11 A specific embodiment of the invention will now be  
12 described, by way of example only, with reference to  
13 the drawings in which:

14

15 Fig 1 shows a schematic perspective view of an  
16 apparatus according to one embodiment of the invention  
17 indicating the location of the pressure sealable  
18 fittings, with a partial cut away view showing the  
19 coalescing medium inside the pipe;

20

21 Fig 2 shows a longitudinal cross section of the  
22 apparatus of Fig 1, indicating the construction of the  
23 media retainer and the extent that the coalescing media  
24 extends through the unit;

25

26 Fig 3 shows a detail on the retaining plate of the  
27 apparatus of Fig 1;

28

29 Fig 4 shows a detail of an alternative to the retaining  
30 plate of Fig 3, in which the coalescing media is  
31 secured to a retaining pin; and

32

33 Figs 5 to 7 are graphs of results of test carried out  
34 using the apparatus of Fig 1, showing the percentage  
35 gain in oil droplet diameter for different coalescing  
36 media fibres.



1 With reference to Figs 1 to 4, the coalescer 10  
2 comprises a pipe 1 of suitable diameter to allow for  
3 the required flow characteristics. Typically the  
4 coalescer of the example has an internal diameter of  
5 100 mm and a length of 2 m. The pipe 1 has an inlet 21  
6 at the end of an inlet branch 20, which is connected to  
7 the pipe near a first end of the pipe. At the second  
8 end of the pipe is an outlet 22.

9  
10 The pipe 1 is fitted into the process system/train by  
11 use of the pressure sealable fittings 23, 24, which  
12 each comprise flanges provided with apertures 25 for  
13 bolted connections.

14  
15 Inside the pipe 1 are the coalescing media 5, which are  
16 supported at one end only by a media retainer plate 4.  
17 The media 5 may be bundles 16 of fibres 30 secured  
18 through apertures 11 in the media retaining plate 4 by  
19 means of a knot 8, as shown in detail in Fig. 3. The  
20 fibres 30 are then free to extend along the interior of  
21 the pipe towards the second end under the action of  
22 liquid flowing along the pipe towards the outlet 22.  
23 Alternatively the fibres 30 may be a single bundle 17  
24 of individual fibres folded in half around a media  
25 retaining pin 14, and secured to the pin 14 by a tie 18  
26 which encircles the folded bundle 17.

27  
28 Access to the coalescer media retainer 4, 14 and media  
29 5 is achieved via the inspection and maintenance access  
30 point 3. The media retainer 4, 14 may be secured in  
31 position by any suitable means. In the example shown  
32 in Fig. 2, the media retaining plate 4 is held by the  
33 clamping action of a threaded cover plate 6 against a  
34 shoulder 7 formed within the pipe 1.

35  
36 The coalescer media 5 is attached to the media retainer

1 4, 14 by any suitable method, depending on the media  
2 that is used. If polypropylene rope is used for the  
3 media 5, connection is achieved by means of knots 8  
4 tied in the ends, as shown in Fig. 2. The individual  
5 ropes or strands 9 of rope are passed through preformed  
6 apertures 11 in the media retaining plate 4, so that  
7 the knots prevent the rope from becoming detached from  
8 the media retaining plate 4. The ropes may  
9 alternatively be secured by clamps, glue or thermal  
10 fusing, as will be apparent to those skilled in the  
11 art. The media 5 may be provided with a sleeve (not  
12 shown) which surrounds the fibres nearest the retaining  
13 plate 4, in order to protect the fibres 30 during  
14 insertion of the media into the pipe. The media 5 may  
15 be provided with protective pads or shields (not shown)  
16 around the point of attachment to the retaining plate  
17 4, in order to prevent abrasion damage to the fibres 30  
18 due to detritus in the fluid stream.

19  
20 In use the two phase liquid enters the apparatus  
21 through inlet 21 and passes along the pipe 1. The  
22 large number of fibres 30 in the coalescing medium 5  
23 means that there is a large surface area of the medium  
24 in contact with the fluid as it passes along the pipe 1  
25 to the outlet 22, encouraging the formation and growth  
26 of droplets of the minority phase on the fibres 30.

27  
28 When the coalescing medium 5 needs to be replaced, the  
29 cover plate 6 is unscrewed, the media retainer 4, 14  
30 can be removed and a new medium 5 is attached to the  
31 retainer 4, 14. Alternatively a new complete unit  
32 comprising a retainer 4, 14 with the media preattached  
33 is used. The retainer 4, 14 is then reinserted in the  
34 pipe 1 and the cover plate 6 screwed in.

35  
36 The invention offers significant advantages over prior

1 art coalescers. Since the fibres 30 are oriented in  
2 the flow direction, there is reduced flow resistance  
3 created. The only resistance to flow arises from the  
4 shear stress between the liquid and the fibres. This  
5 is of particular importance when the apparatus of the  
6 invention is used in a low pressure process train.  
7 Tests have shown that pressure drops across the  
8 coalescer of the invention of less than 1.0 bar may be  
9 achieved. This compares with a pressure drop of 1.8  
10 bar when using a prior art hydrocyclone coalescer. The  
11 apparatus of the invention can operate successfully  
12 under a range of flow conditions, coalescing droplets  
13 of less than 10 micron diameter with flow conditions  
14 varying from Re (Reynolds Number) 30,000 to 100,000.  
15 Tests show that if the invention is used with a  
16 hydrocyclone, the efficiency of the hydrocyclone can be  
17 improved from 30% to 90% for small droplet sizes.

18  
19 The coalescer of the invention may be easily  
20 retrofitted. It has a low cost, since low cost fibres  
21 such as polypropylene, nylon, hemp, cotton and hair may  
22 be used for the coalescing fibre. The best results  
23 have been obtained with polypropylene in the form of  
24 rope, mop or ribbon-type strands such as Sorbaine (TM).

25  
26 The coalescing apparatus of the invention is used to  
27 form larger droplets of the minority phase in the fluid  
28 stream. Its effectiveness can be measured by the  
29 increase in droplet size which it achieves. Larger  
30 droplets may be separated more effectively by a  
31 cyclone, so that the passing of a fluid stream through  
32 a coalescing apparatus according to the invention  
33 before passing the fluid stream to a cyclone or other  
34 separation device improves the efficiency of the  
35 separation device.

36

1     EXAMPLES

2  
3     Tests have been carried out to measure the effect on  
4     droplet size of different coalescing media. The  
5     results, using water and oil at 50°C in a test  
6     apparatus similar to that shown in Figs 1 and 2, are  
7     shown in Figs 5 to 7. Sorbaine (TM) is a proprietary  
8     polypropylene fibre in ribbon form. Fig 5 shows that  
9     under high flow conditions (Reynolds Number 50,000)  
10    polypropylene mop (a tortuous polypropylene fibre) and  
11    hemp string achieved oil droplet size growth of more  
12    than 40%. Fig 6 shows that under medium flow  
13    conditions (Reynolds Number 30,000) polypropylene mop  
14    and Sorbaine both achieved oil droplet size growth of  
15    more than 40%. Fig 7 shows that under low flow  
16    conditions (Reynolds Number 15,000) Sorbaine achieved  
17    oil droplet size growth of more than 40%.

1     The modifications described in this specification and  
2     other modifications and improvements can be  
3     incorporated without departing from the scope of the  
4     invention as defined in the appended claims.

## 1 CLAIMS:

2

3 1. An apparatus for coalescing droplets of one phase  
4 from a fluid comprising two or more phases, said  
5 apparatus comprising a chamber (1), a coalescing  
6 medium (5) comprising a plurality of substantially  
7 elongate members (30) each having a surface area,  
8 a retaining member (4, 14) to which the coalescing  
9 medium (5) is secured, an inlet (21) to said  
10 chamber, and an outlet (22) from said chamber,  
11 said inlet and outlet being positioned such that  
12 fluid flowing from said inlet (21) to said outlet  
13 (22) flows in a flow direction in contact with  
14 said surface area of said coalescing medium, the  
15 elongate members (30) extending substantially in  
16 the flow direction, characterised in that said  
17 chamber is formed from a substantially straight  
18 pipe having a first end and a second end and a  
19 branch intermediate said first and second ends,  
20 said outlet (22) being arranged at the first end  
21 and an access cover (6) being arranged at the  
22 second end, said inlet (21) being arranged at the  
23 free end of said branch, wherein said access cover  
24 is adapted to allow removal and replacement of the  
25 retaining member (4, 14) and coalescing medium  
26 (5).

27

28 2. An apparatus in accordance with Claim 1, wherein  
29 said retaining member (4, 14) is adapted to be  
30 removably engaged within said chamber.

31

32 3. An apparatus in accordance with Claim 1 or Claim  
33 2, wherein the interior of said chamber is  
34 provided with a shoulder (7) adapted to engage  
35 with said retaining member.

AMENDED SHEET

- 1      4.    An apparatus in accordance with Claim 3, wherein  
2            said access cover (6) is adapted to hold said  
3            retaining member (4, 14) against said shoulder (7)  
4            when the access cover (6) is attached to the pipe  
5            (1).  
6
- 7      5.    An apparatus in accordance with any of Claims 1 to  
8            4, wherein said retaining member (4) is provided  
9            with one or more apertures (11) for securing said  
10           coalescing medium (5) to said retaining member  
11           (4).  
12
- 13     6.    An apparatus in accordance with any preceding  
14           claim, wherein said plurality of elongate members  
15           are substantially mutually aligned fibres (30).  
16
- 17     7.    An apparatus in accordance with Claim 6, wherein  
18           said coalescing medium (5) comprises ribbon-like  
19           fibres.  
20
- 21     8.    An apparatus in accordance with Claim 6, wherein  
22           said fibres (30) are selected from the group of  
23           materials comprising polypropylene, metal wire,  
24           animal hair, polyethylene, polyester, and glass  
25           wool.  
26
- 27     9.    An apparatus in accordance with any of Claims 1 to  
28           6, wherein said coalescing medium (5) comprises  
29           one or more polypropylene ropes.  
30
- 31     10.   A method for coalescing droplets of one phase from  
32           a fluid comprising two or more phases using the  
33           apparatus of any preceding Claim, in which the  
34           fluid is caused to flow in a flow direction  
35           through the chamber (1), each of the plurality of

1 substantially elongate members (30) being  
2 substantially aligned in the flow direction, such  
3 that the fluid flows in contact with said surface  
4 area of said coalescing medium (5) and droplets of  
5 a first phase of said fluid coalesce on said  
6 surface area.

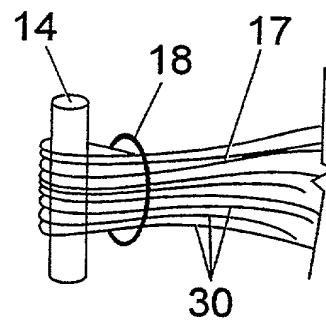
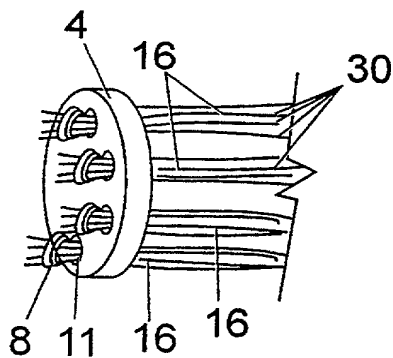
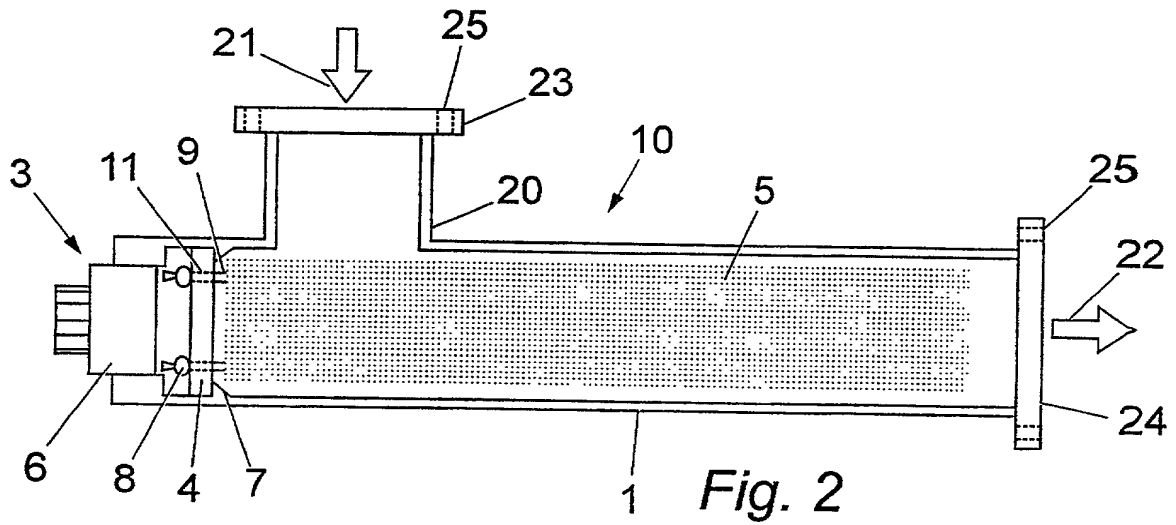
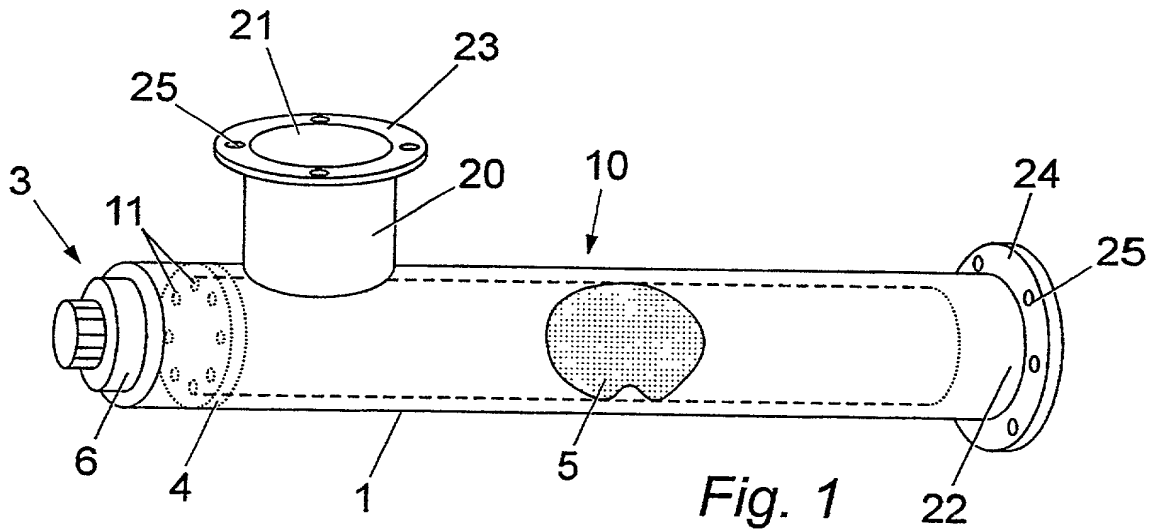
7  
8 11. A method in accordance with Claim 10, wherein the  
9 fluid is a liquid.

10  
11 12. A method in accordance with Claim 11, wherein the  
12 fluid is a mixture of water and oil, and wherein  
13 the first phase is oil.

14  
15 /u/mur/specs22/p22101.claims

AMENDED SHEET

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2 / 2

Comparison of materials at Re 50,000

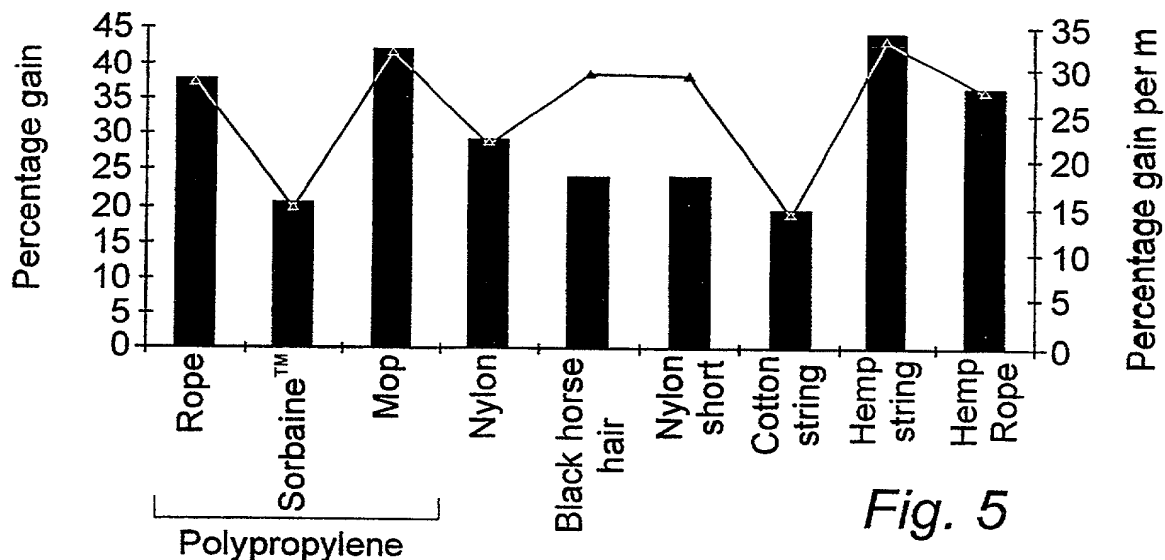


Fig. 5

Comparison of materials at Re 30,000

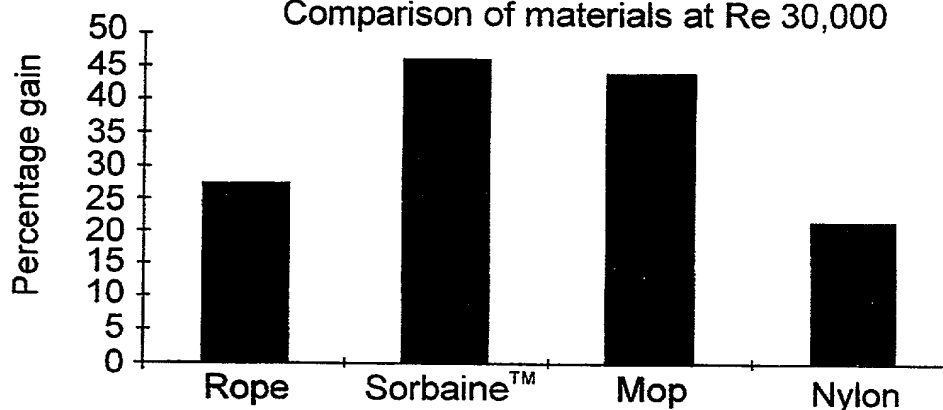


Fig. 6

Comparison of materials at Re 15,000

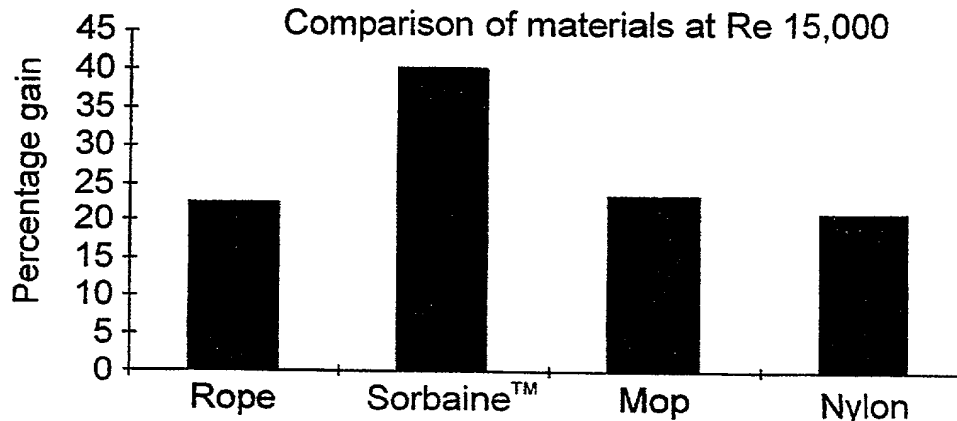


Fig. 7

# DECLARATION FOR PATENT APPLICATION

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled COALESCER, the specification of which

(check  
one)

☒

is attached hereto.

☐

was filed on \_\_\_\_\_ as  
Application Serial No. \_\_\_\_\_  
and was amended on \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Patent Office all information known to me to be material to patentability as defined in 37 C.F.R. 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
PCT/GB99/02029	United Kingdom	28 June 1999	<input checked="" type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
_____	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
_____	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose to the Patent Office all information known to me to be material to patentability as defined in 37 C.F.R. 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status)
_____	_____	(patented, pending, abandoned)

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~~San Francisco, California 94111-4187~~

File No. A-70162/JAS

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Title 18, United States Code, §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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first inventor:

1-00  
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